High Efficiency 4 K Cryocooler for Space Missions, Phase I

Completed Technology Project (2018 - 2019)

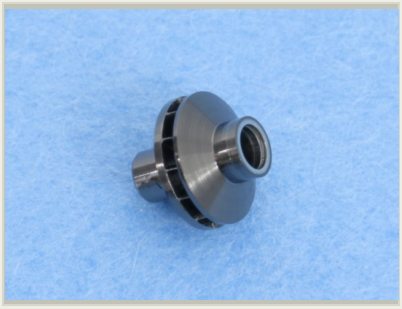
Project Introduction

Future astrophysics missions require efficient, low-temperature cryocoolers to cool advanced instruments or serve as the upper stage cooler for sub-Kelvin refrigerators. Potential astrophysics missions include Lynx, the Origin Space Telescope, and the Superconducting Gravity Gradiometer. Cooling loads for these missions are up to 300 mW at temperatures of 4 to 10 K, with additional loads at higher temperatures for other subsystems. Due to low jitter requirements, a cryocooler with very low vibration is needed for many missions. In addition, a multi-stage cooler, capable of providing refrigeration at more than one temperature simultaneously, can provide the greatest system efficiency with the lowest mass. Turbo-Brayton cryocoolers have space heritage and are ideal for these missions due to negligible vibration emittance and high efficiency at low temperatures. The primary limitation in implementing Brayton cryocoolers at temperatures below 10 K has been the development of high efficiency turbines. On the proposed program, Creare plans to leverage recent developments in gas bearing technology and low-temperature alternators to realize a high-efficiency, low-temperature turbine. On the Phase I project, we will perform a proof-of-concept demonstration of the turbine technology at temperatures down to 4 K. On the Phase II project, we will build and demonstrate an advanced low-temperature turbine at temperatures of 4 to 10 K.

Anticipated Benefits

The successful completion of this program will result in an extremely efficient low-temperature cryocooler with negligible vibration. This type of cryocooler is ideal as the upper-stage cryocooler or primary cooler for cooling advanced, low-temperature space instruments. Potential NASA missions include the Lynx, Origin Space Telescope, and the Superconducting Gravity Gradiometer.

The military market for the technology is for cooling hyperspectral imaging systems on space-based observation, surveillance, and missile defense systems. Commercial applications for this technology include cooling for communication satellites; superconducting instruments, digital filters, and magnets; low-temperature gas-separation systems; hypercomputers; and Superconducting Quantum Interference Devices (SQUIDs).



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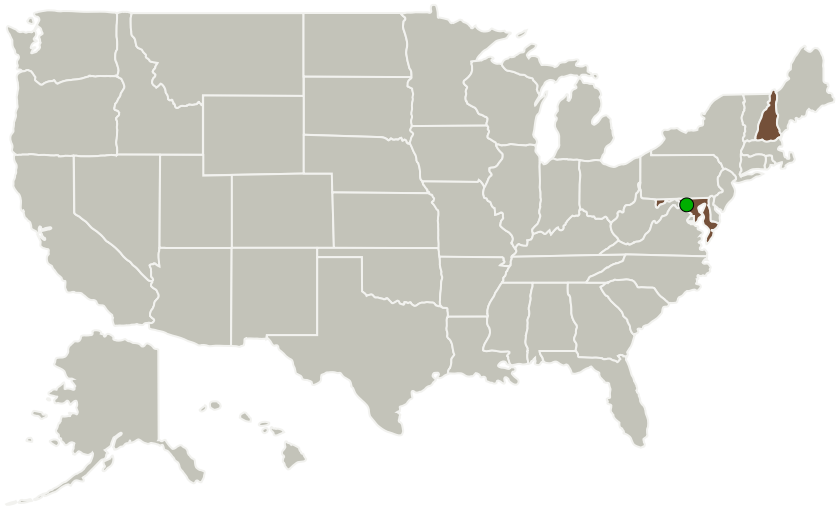
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Creare LLC	Lead Organization	Industry	Hanover, New Hampshire
Goddard Space Flight Center(GSFC)	Supporting Organization	NASA Center	Greenbelt, Maryland

Primary U.S. Work Locations	
Maryland	New Hampshire

Project Transitions

July 2018: Project Start

February 2019: Closed out

Closeout Documentation:

- Final Summary Chart*(https://techport.nasa.gov/file/141071)*

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Creare LLC

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management

Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Mark Zagarola

Co-Investigator:

Mark Zagarola

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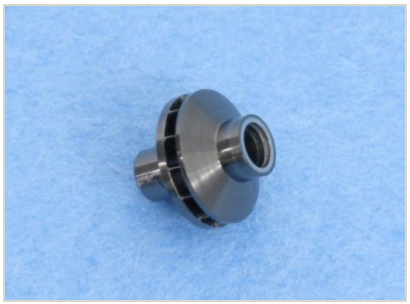
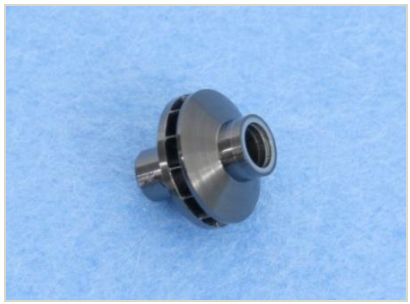
Images



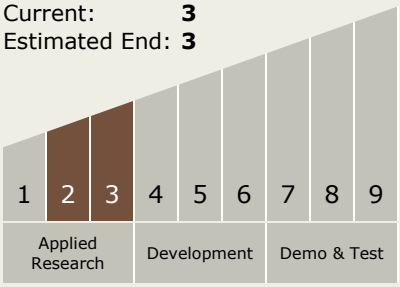
Briefing Chart Image
High Efficiency 4 K Cryocooler for Space Missions, Phase I
(https://techport.nasa.gov/image/129988)



Final Summary Chart Image
High Efficiency 4 K Cryocooler for Space Missions, Phase I
(https://techport.nasa.gov/image/127841)

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX08 Sensors and Instruments
  - TX08.1 Remote Sensing Instruments/Sensors
    - TX08.1.6 Cryogenic / Thermal

Target Destination

Outside the Solar System